



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : B04B 5/08, F01N 3/02, F01M 13/04		A1	(11) International Publication Number: WO 99/56883
			(43) International Publication Date: 11 November 1999 (11.11.99)
(21) International Application Number: PCT/SE99/00695		(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 28 April 1999 (28.04.99)			
(30) Priority Data: 9801567-0 4 May 1998 (04.05.98) SE			
(71) Applicant (for all designated States except US): ALFA LAVAL AB [SE/SE]; Hans Stahles väg, S-147 80 Tumba (SE).			
(72) Inventors; and			
(75) Inventors/Applicants (for US only): BORGSTRÖM, Leonard [SE/SE]; Rönnbärsvägen 8, S-135 42 Tyresö (SE). CARLSSON, Claes, Göran [SE/SE]; Skogshemsvägen 63B, S-146 36 Tullinge (SE). FRANZÉN, Peter [SE/SE]; Månstorpssvägen 22, S-146 45 Tullinge (SE). INGE, Claes [SE/SE]; Kristinavägen 15, S-131 50 Söðtsjö-Duvnäs (SE). LAGERSTEDT, Torgny [SE/SE]; Döbelnsgatan 89, S-113 52 Stockholm (SE). MOBERG, Hans [SE/SE]; Björngårdsgatan 16 B, S-118 52 Stockholm (SE). SZEPESSY, Stefan [SE/SE]; Repslagargatan 18, S-118 46 Stockholm (SE). MYRVANG, Tommy [SE/SE]; Bergsunds Strand 7, S-117 38 Stockholm (SE).			
(74) Agent: CLIVEMO, Ingemar; Alfa Laval AB, S-147 80 Tumba (SE).			

Published

With international search report.

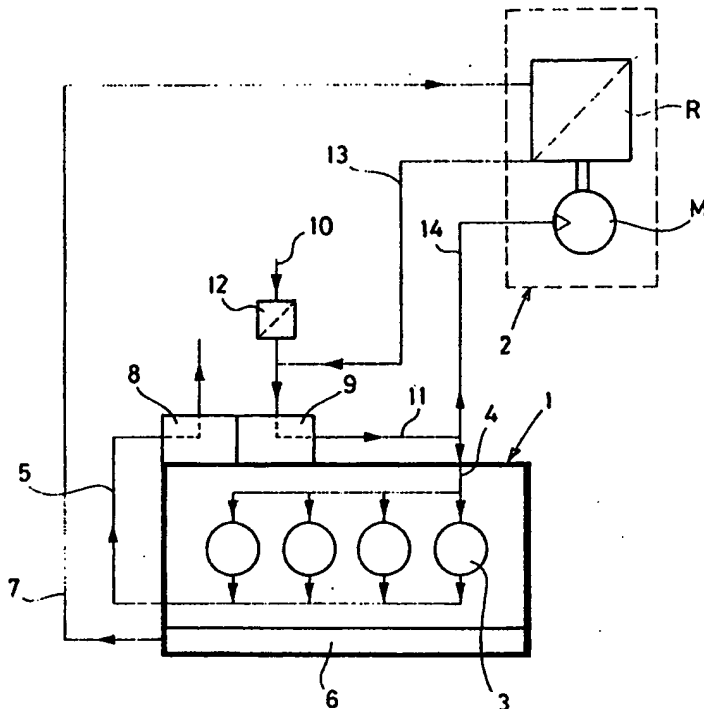
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

In English translation (filed in Swedish).

(54) Title: METHOD AND PLANT FOR CLEANING OF GASES FROM A COMBUSTION ENGINE

(57) Abstract

Gases produced by a combustion engine (1), e.g. crankcase gases, are conducted through a separation chamber formed and surrounded by a centrifugal rotor (R), by means of which the gases are caused to rotate, so that particles suspended in the gases are separated by means of centrifugal force. The centrifugal rotor (R) is caused to rotate by means of a pressure fluid that is generated by means of the combustion engine (1).



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

METHOD AND PLANT FOR CLEANING OF GASES FROM A COMBUSTION ENGINE.

The present invention relates to cleaning of gases produced by a combustion engine from solid and/or liquid particles suspended therein. Gases of this kind are both combustion gases leaving the engine through its ordinary exhaust pipe and, for instance, so-called crankcase gases, i.e. combustion gases released through the crankcase of the engine, to which they have been pressed from the engine cylinders past the piston rings of the engine pistons. Crankcase gases have to be released so that they do not create an all too high gas pressure in the crankcase, and they contain in addition to combustion products, such as soot particles, also an amount of oil drops entrained from the oil mist having been formed and being present in the crankcase during the operation of the combustion engine.

For cleaning of gases of this kind various types of devices have been suggested previously, by means of which the gases may be brought into a rotational movement, so that the particles suspended in the gases may be separated by centrifugal force. Thus, it has been suggested that the gases should flow through a cyclone having one or more tangential inlets for the gases or flow through a chamber of a stationary housing, in which they are caused to rotate by means of a central driving wheel provided with wings or other entrainment members, e.g. as can be seen from US - A - 1,950,586 or DE 43 11 906 A1. Furthermore, it has been suggested that the gases should flow through channels or a separation chamber within a rotating member driven in one way or another by means of the combustion engine. According to one suggestion a rotating member of this kind would be driven by means of some rotating part of the combustion engine, as shown for instance in EP 0 736 673 A1, DE 196 07 919 A1 and US 4,329,968. According to another suggestion the rotating member would be driven by means of kinetic energy of the gases which have been produced by the combustion engine and which

are to be cleaned, as shown for instance in GB 1 465 820 and DE 35 41 204 A1.

The above-mentioned suggestions for cleaning of gases having been
5 produced by a combustion engine each have one or more drawbacks.
Thus, the suggestions based on the gases being caused to flow through
a chamber formed by a stationary housing and being caused to rotate
therein by means of a driving wheel or the like, which is provided with
wings or similar entrainment members, have the disadvantage that a
10 sufficiently effective separating operation is difficult or impossible to
accomplish by means of this kind of technique. The suggestions being
based on use of a rotatable member, which within itself forms a
separation chamber through which the gases are to flow, have the
disadvantage that the suggested methods of operating such a rotatable
15 member either are difficult to use, if a very large rotational speed is
desired for the rotating member, or put certain demands on the physical
location of the rotatable member. It is often a desire that it should be
possible to locate an equipment for cleaning of gases from a combustion
engine at a desired place at or at a distance from the combustion engine.

20

A starting point of the present invention for cleaning of gases of the kind
here in question is the use of a rotatable centrifugal rotor, which forms
and surrounds a separation chamber, through which the gases should be
brought to flow. Only by means of a centrifugal rotor of this kind a
25 sufficiently effective cleaning of the gases is supposed to be achievable.
Also, an object of the invention is to accomplish driving of said centrifugal
rotor in a way which enables, in a simple manner, both that a very high
rotational speed can be achieved and that the centrifugal rotor can be
located at a desired place near the combustion engine.

30

According to the invention it is proposed for the fulfillment of this object a method of cleaning gases, having been produced by a combustion engine, from solid and/or liquid particles suspended therein, which method thus takes as a starting point in that the gases are conducted
5 through a separation chamber formed and surrounded by a rotating member, by means of which the gases are brought to rotate, so that the particles are separated from the gases in the separation chamber by means of centrifugal force, and which method is characterised in that the combustion engine is used to generate a pressure fluid other than that
10 constituted by exhaust gases pressurised in the combustion room of the combustion engine, and that this pressure fluid is used for the driving of the rotating member.

By the method according to the invention it is achieved, firstly, that an
15 effective centrifugal separator can be used, in which a centrifugal rotor can be driven by means of pressure fluid at a very high rotational speed and, secondly, that a centrifugal rotor of this kind — as a consequence of the fact that it is drivable by means of a pressure fluid which can be simply conducted to any desired place — can be arranged in a best
20 possible space within or in the vicinity of the combustion engine.

Normally, a combustion engine pressurises for its own need fluids of different kinds. For instance fuel, lubricating oil and cooling water are pressurised. This is accomplished by means of pumps which in one way
25 or another are operated by means of energy from the combustion engine. Furthermore, in certain cases the air, which has to be supplied to the combustion room of the engine, is pressurised by means of a compressor. Normally, this is driven by the exhaust gases leaving the combustion engine.

According to various modifications of the invention fluids having been pressurised in manners like this may be used for operation of the rotatable member in the aforementioned separator. The operation of the rotatable member may be accomplished by means of a turbine wheel or a
5 similar member, which is connected — directly or through a gear device — with the rotatable member of the separator. An operation of this kind can be accomplished independently of whether the pressurised fluid is constituted by a liquid or a gas. The driving can be accomplished alternatively by means of a hydraulic or pneumatic motor of one kind or
10 another.

One way of driving the rotatable member is to conduct all or part of the pressurised fluid into a rotatable housing, which is directly — or indirectly through a gear device — connected with the rotatable member, at least
15 part of the fluid being caused to leave the housing through an outlet that is directed and placed such in relation to a rotational axis, around which the housing is rotatable, that the fluid leaving through the outlet will bring the housing and said rotatable member into rotation. This driving method can be used independently of whether the pressure fluid is constituted by
20 a gas or a liquid.

Particularly in connection with diesel engines it is common that lubricating oil is cleaned by causing a part flow of the lubricating oil, which is pumped to relevant lubricating places in the engine, to pass through a so-called
25 reaction-driven centrifugal separator. A centrifugal separator of this kind has a rotor, in which pressurised lubricating oil is introduced, one or several outlets for lubricating oil leaving the rotor being so placed and directed that the rotor, as a consequence of the outflow of lubricating oil, is brought and kept in rotation. According to a particular application of the
30 invention, a centrifugal separator of this kind for lubricating oil may be

used for driving of the rotatable member in the aforementioned separator for cleaning of gases from the combustion engine. Thus, this rotating member may be carried by or be driven in some suitable way by the rotor in the centrifugal separator for lubricating oil.

5

It is of course possible within the scope of the present invention to use the combustion engine for pressurisation of a fluid, which is intended solely for the operation of said rotatable member or, at least, is not intended for any other need of the combustion engine. Thus, the combustion engine
10 may be adapted for operation of an electric generator, electricity from this electric generator being used for pressurisation of a fluid. For instance, an electrically driven compressor for pressurisation of air, intended for operation of said rotatable member, may be coupled to an electric generator of this kind.

15

The invention also concerns a plant for performing the above described method of cleaning gases which have been produced by a combustion engine.

20 A plant of this kind comprises a centrifugal separator having a rotor, which is rotatable around a rotational axis and which delimits and surrounds a separation chamber, and gas conducting members for conducting said gases from the combustion engine into the rotor separation chamber, so that they are caused to rotate therein. The plant
25 is characterised in that the combustion engine is adapted for operation of a pressurisation device for generating a pressure fluid other than that constituted by exhaust gases pressurised in the combustion room of the combustion engine, that the centrifugal separator has a driving device for said rotor, which driving device is adapted to cause rotation of the rotor by
30 means of a pressure fluid, and that pressure fluid conducting members

are adapted to conduct pressure fluid from said pressurising device to said driving device for rotation of the rotor.

Various embodiments of a plant according to the invention are described
5 in the following with reference to the accompanying drawings.

The figures 1 - 4 show schematically a combustion engine and a centrifugal separator for cleaning of so-called crankcase gases leaving the combustion engine, and illustrate various drive sources for driving of a
10 rotor in the centrifugal separator according to the invention.

Figure 5 shows a particular embodiment of a centrifugal separator for cleaning of gases coming from a combustion engine, combined with a reaction-driven centrifugal separator for cleaning of lubricating oil.
15

The figures 6 and 7 show schematically different further kinds of centrifugal separators for gas cleaning in accordance with the invention.

Each one of the figures 1 - 4 shows schematically a combustion engine 1
20 and a centrifugal separator 2 for cleaning of gases having been produced by the combustion engine 1. The engine 1 has four cylinders 3, which are charged with air through a conduit 4 and which emit combustion exhaust gases through an exhaust gas conduit 5. The supply of fuel to the cylinders 3 is not shown in the figures 1-3, but is illustrated schematically
25 in figure 4. The engine 1 further has a crankcase 6, which is partly filled with lubricating oil. Into this crankcase 6 come certain combustion gases, which pass the piston rings of the engine cylinders 3 and which have to be removed from the crankcase. Such so-called crankcase gases are conducted away through a conduit 7 opening into the centrifugal separator

30 2.

The exhaust gases leaving the cylinders 3 through the conduit 5 are further conducted through a so-called turbo unit 8, in which they are caused to drive a compressor 9 arranged for compression of air. Such air enters the compressor through an inlet conduit 10 and is pressed out of the compressor through an outlet conduit 11 into the aforementioned conduit 4 conducting the compressed air to the cylinders 3. A filter 12 is placed in the inlet conduit 10 for cleaning of incoming air. Crankcase gases having been cleaned from particles in the centrifugal separator 2 enter the inlet conduit 10 for air through a conduit 13, which is connected downstream of the filter 12.

Figure 1 shows a plant, in which the centrifugal separator 2 is driven by means of part of the pressurised air having been generated by the compressor 9. Thus, a driving air conduit 14, which opens into the centrifugal separator 2, starts from the compressor outlet conduit 11.

Figure 2 shows a plant, in which the centrifugal separator 2 is driven by means of pressurised lubricating oil. Thus, there is shown a lubricating oil pump 16, which is charged with lubricating oil from the crankcase 6 through a conduit 17 and which pumps lubricating oil of this kind both through a conduit 18 to various lubricating places in the combustion engine 1 and through a conduit 19 to the centrifugal separator 2 for its operation. Through a conduit 20 lubricating oil from the centrifugal separator 2 is returned to the crankcase 6.

25

Figure 3 shows a plant, in which the centrifugal separator 2 is driven by means of pressurised cooling water. Thus, a cooling unit 21, which is adapted to be flowed through by cooling water for the cooling thereof, is schematically shown. A water pump 22 is adapted to be charged with cooled water from the cooling unit 21 through a conduit 23 and to pump

30

this water through a conduit 24 to different cooling places within the engine 1. Through not shown channels in the engine 1 the cooling water is then returned to the cooling unit 21. Through a conduit 25, starting from the conduit 24, part of the cooling water is also pumped to the centrifugal separator 2 for the operation of the latter. Cooling water of this kind is returned to the suction side of the pump 22 through a conduit 26.

Figure 4 shows a plant, in which the centrifugal separator is driven by means of pressurised fuel, e.g. fuel oil, intended for the operation of the engine. Thus, there is shown schematically a fuel tank 27, from which a fuel pump 28 is charged with fuel through a conduit 29 and pumps it further on through a conduit 30 to the engine 1. Through a branch conduit 31 of the conduit 30 part of the fuel is pumped to the centrifugal separator 2 for its operation. Fuel of this kind is returned through a conduit 32 to the fuel tank 27.

In each one of the plants according to the figures 1-4 the centrifugal separator is adapted to be driven by means of a pressure fluid, the pressure of which has been generated by means of the combustion engine 1. The pumps 16, 22 and 28 are, thus, adapted to be driven in one way or another by the combustion engine 1. The driving device then used for the operation of the centrifugal separator may be of any suitable kind. Thus, for instance some kind of a hydraulic or pneumatic rotational motor may be chosen. Alternatively, a turbine wheel may be adapted to be rotated by the pressure fluid and be connected, or coupled through a gear device, to the rotor of the centrifugal separator. Alternatively, said rotor may be driven by a reaction force generated when the pressure fluid leaves a rotatable body through suitably designed outlet nozzles. In the figures 1-4 the rotor of the centrifugal separator is designated R and the driving device or motor is designated M.

Figure 5 shows a particular embodiment of a centrifugal separator according to the invention and, likewise particular, a driving device for the rotor of the centrifugal separator.

5 The apparatus in figure 5 comprises a stationary housing consisting of a lower housing part 39 and an upper housing part 40. Within the housing there is delimited a chamber 41, in which there is arranged a rotor 42. The rotor is journalled at 43 in the lower housing part 39, so that it is rotatable around a vertical rotational axis.

10

The rotor 42 is adapted both for cleaning of lubricating oil, intended for lubrication of the combustion engine 1 according to figure 2, and for cleaning of crankcase gases coming from the same combustion engine 1 according to figure 2. The rotor 42 is adapted to be driven by means of
15 the pressure of the lubricating oil being supplied from the lubricating oil pump 16 through the conduit 19 in figure 2. The conduit 19 opens into an inlet channel 44 in the lower housing part 39 in figure 5. Further, the lower housing part 39 in figure 5 receives through a gas inlet 45 crankcase gases supplied to the centrifugal separator through the conduit 7 in
20 figure 2.

The rotor 42 in figure 5 includes a lower base plate 46 and a cover 47 placed thereon. The base plate 46 and the cover 47 surround a space intended to be filled and be flowed through by lubricating oil to be
25 cleaned. An inlet pipe 48, which supports both the base plate 46 and the cover 47 and which is rotatably journalled in the lower housing part 39, extends centrally through the base plate 46 and the cover 47.

Within the rotor 42 the base plate 46 supports a frusto-conical partition
30 49, which divides the just mentioned space into a separation chamber 50

and an outlet chamber 51. The inlet pipe 48 carries a cylindrical sleeve 52, which between itself and the inlet pipe 48 delimits an inlet chamber 53. The inlet chamber 53 communicates at its lower part through a number of openings 54 with the interior of the inlet pipe 48 and at its upper part with the upper part of the separation chamber 50. The interior of the inlet pipe 48 communicates through a supply chamber 55 in the lower housing part 39 with the inlet channel 44 for lubricating oil to be cleaned.

10 The base plate 46 has on its underside two protuberances 56, the hollow interior of which communicates with the outlet chamber 51. In each protuberance 56 there is arranged an outlet nozzle 57, which is placed at a distance from the rotational axis of the rotor 42 and which is directed in the circumferential direction of the rotor.

15

A cylindrical filter 58 surrounding the inlet pipe 48 extends within the separation chamber 50 from the frusto-conical partition 49 to the cylindrical sleeve 52.

20 The part of the centrifugal separator in figure 5, which is intended for cleaning of lubricating oil, operates in the following manner.

Lubricating oil supplied by an overpressure through the channel 44 is conducted through the supply chamber 55 and the interior of the inlet pipe 25 48 into the inlet chamber 53. From there it is conducted further on through the separation chamber 50, through the filter 58 to the outlet chamber 51 and, from there, through the outlet nozzles 57 out of the rotor 42.

Leaving the rotor 42 the lubricating oil by a reaction force on the rotor brings this into rotation. This means that the lubricating oil flowing through the separation chamber 50 is subjected to centrifugal force, so that particles suspended in the lubricating oil and being heavier than that are
5 separated and collected at the inside of the cover 47. The cleaned lubricating oil leaves, as said, the rotor 42 through the nozzles 57 and enters the chamber 41. From there the lubricating oil runs through the gas inlet 45 back to the crankcase of the combustion engine through the conduit 20 (see figure 2).

10

As can further be seen from figure 5, the cover 47 carries on its upper side a further separation device comprising a cylindrical surrounding wall 59 and several frusto-conical partitions 60, which are supported by said surrounding wall 59 spaced axially from each other and which are coaxial
15 with the rotor 42. The surrounding wall 59 and the partitions 60, thus, are rotatable together with the cover 47 and constitute part of the rotor 42.

A central pipe 61, which is supported by the stationary upper housing part 40, extends downwardly centrally in the cylindrical surrounding wall 59.
20 The pipe 61 supports axially separated conical partitions 62, which extend from the pipe 61 out into the interspaces between said frusto-conical partitions 60 supported by the surrounding wall 59. Hereby, there is formed between the rotatable surrounding wall 59 and its partitions 60, on one side, and the stationary central pipe 61 and its partitions 62, on the
25 other side, a labyrinth path through the just described separation device from its upper to its lower part.

The central pipe 61 ends at its lower part in a funnel-formed partition 63, which is situated at some distance from the upper side of the cover 47.
30 Thus, as is illustrated by means of arrows in figure 5, it is possible for

crankcase gases entering the chamber 41 through the gas inlet 45 to flow into the upper separation device and through a labyrinth path to and out through the interior of the central pipe 61. While flowing through said labyrinth way the crankcase gases are brought into rotation as a
5 consequence of the rotation of the surrounding wall 59 and the partitions 60. Hereby, solid particles and oil drops are separated by the centrifugal force from the crankcase gases, said particles and liquid drops depositing on the surrounding wall 59. Through holes 64 in the radially outermost parts of the partitions 60 and holes 65 in the lowermost part of the
10 surrounding wall 59 separated liquid and entrained separated particles will leave the rotor 42 and, together with oil having been discharged out into the chamber 41 from the rotor 42 through the nozzles 57, flow back through the gas inlet 45 and the returning conduit 20 to the crankcase 6 of the combustion engine (see figure 2).

15

Cleaned crankcase gases leave through the central pipe 61 and are conducted through the conduit 13 (see figure 2) back to the combustion engine inlet for air. Alternatively, these gases may be released to the surroundings.

20

As explained, pressurised lubricating oil is used for driving of the gas separator in figure 5. However, of course a rotor designed as the upper part of the rotor 42, i.e. comprising the surrounding wall 59, the partitions 60 and a bottom wall similar to the uppermost part of the cover 47, may
25 be driven in any one of the other ways to be seen from the figures 1-4.

Figure 6 shows a centrifugal separator of a different kind. A stationary housing 66, consisting of two parts, surrounds a rotor 67 that is rotatable around a rotational axis 68. The rotor 67 defines an annular separation
30 chamber 69, in which there is arranged a likewise annular separation

insert 70. This separation insert comprises an annular plate 71, which is supported on the inside of the surrounding wall of the rotor at the upper part thereof. The plate 71 has a number of through holes 72 distributed around the rotational axis 68.

5

Suspended from the underside of the plate 71, radially inside the holes 72, is a cylindrical support 73, on the outside of which there are fastened a lot of bristles, which are illustrated by means of a lot of parallel lines. The bristles extend from the supporter 73 to or close to the surrounding wall of the rotor 67 substantially perpendicular to the rotational axis 68.

10

Centrally into the rotor 67 is extending from above an inlet pipe 74, which is supported by the stationary housing 66. In the upper limiting wall of the housing there are several outlet openings 75 distributed around the inlet pipe 74.

15

The rotor may be rotatable in any suitable way, e.g. some of those previously described with reference to the figures 1-5.

20 A gas (or gases) to be cleaned from particles suspended therein and being heavier than the gas, is introduced into the rotor through the inlet pipe 74 and may flow to the lower part of the separation chamber 69. From there the gas is conducted vertically upwardly, with reference to figure 6, through the part of the separation chamber 69 in which there are
25 bristles. By the bristles the gas is entrained in their rotation, the heavy particles being separated from the gas, which continues upwardly and out of the rotor 67 through the holes 72 and further out of the housing 66 through the outlet openings 75.

The particles separated from the gases, which may be solids or liquid drops, move towards the surrounding wall of the rotor 67 between the bristles. Certain particles, maybe most of them, will then be brought into contact with the bristles and will slide along them by the centrifugal force towards said surrounding wall. Like the surrounding wall 59 of the rotor in figure 5 the surrounding wall of the rotor in figure 6 may be provided with small outlet holes for continuous discharge of separated particles to the space between the rotor 67 and the housing 66. Above all, if the particles are in the form of liquid drops, such a continuous discharge of separation products is suitable.

As an alternative to one or more holes through the surrounding wall of the rotor 67 may serve for continuous discharge of separated liquid from the rotor a stationary outlet device, which is adapted to discharge liquid during the rotation of the rotor at a certain distance from the rotational axis 68. A stationary outlet device of this kind may comprise a so-called paring pipe, which extends from above into the upper part of the rotor and opens at 76 in the vicinity of the rotor surrounding wall axially between the outlet holes 72 and an internal flange 77 of said surrounding wall. If there are no outlet holes through the surrounding wall of the rotor or some other arrangement for discharge of material separated from the gases, the rotor 67 has to be stopped and cleaned at certain time intervals.

Figure 7 shows a further embodiment of a centrifugal separator for cleaning of a gas from particles suspended therein and being heavier than the gas. The centrifugal separator in figure 7 is similar to the centrifugal separator in figure 6 and corresponding parts of these centrifugal separators have therefore been given the same reference numerals 66-72 and 74-77.

The separation insert 70 in figure 7 comprises several frusto-conical separation discs, which are placed in the separation chamber 69 coaxially with each other and at some axial distance from each other. Hereby, thin flow paths are formed between the separation discs from the radially inner edges to their radially outer edges. As can be seen from figure 7, the separation discs are kept radially spaced from the surrounding wall of the rotor 67 by means of an axial rib 78. Several ribs of this kind are arranged spaced from each other around the separation insert 70. The purpose of them is both to keep the conical separation discs in correct positions in the chamber 69 and to create between the separation discs and the surrounding wall of the rotor axial flow parts for gas having been cleaned or gas which is to be cleaned from particles.

Also the rotor in figure 7 may be rotatable in any suitable way, for instance some of those previously described with reference to the figures 1-5.

Gas (or gases) to be cleaned from particles suspended therein and being heavier than the gas, is introduced into the rotor 67 through the inlet pipe 74. From the central part of the rotor the gas is distributed and flows further on towards the surrounding wall of the rotor through the thin interspaces between the conical separation discs. In these interspaces the gas is brought into rotation by the separation discs and possible spacing members arranged therebetween, the particles being separated from the gas by being thrown by the centrifugal force towards the undersides of the conical separation discs. On these undersides the separate particles slide, or a liquid formed by separated liquid drops flows, further towards the surrounding wall of the rotor. On the inside of the surrounding wall of the rotor separated material is thus collected, from where it can be removed either intermittently, e.g. manually when the

rotor has been stopped, or continuously by the rotor surrounding wall being provided with openings similar to the openings 65 of the surrounding wall 59 in figure 5. Alternatively, the centrifugal separator in figure 7 may be provided with a stationary outlet device for separated
5 liquid of the kind previously described in connection with the centrifugal separator in figure 6. If a paring tube is used, it is important that this is adjusted such that a free liquid surface is formed in the rotor radially outside the outer edges of the conical separation discs, so that cleaned gases may flow axially past these outer edges and leave the rotor through
10 the holes 72. Otherwise, separate holes have to be formed in the separation discs, which creates unnecessary throughflow resistance for the cleaned gases.

In the centrifugal separators according to the figures 6 and 7 it has been
15 assumed that gas to be cleaned is introduced through the pipe 74 and that cleaned gas leaves through the openings 75, which are situated at a substantially larger distance from the rotor rotational axis than is the inlet tube 74. Hereby it is achieved that the rotor operates as a fan, which creates a certain underpressure in the inlet pipe 74. The gas to be
20 cleaned then need not be pressurised in order to be able to flow through the rotor. At both centrifugal separators it is possible, however, to have the gas flowing in the opposite direction.

It has been suggested above that the centrifugal separator in figure 7
25 should be used for cleaning of gas or gases generated by a combustion engine. However, this kind of centrifugal separator may be used also for cleaning of any gas or any gases from solid or liquid particles suspended therein, which are heavier than the gas or gases, respectively.

Like in use in connection with cleaning of liquids the conical separation discs in this centrifugal separator may be provided with differently designed spacing members in the interspaces between the separation discs. A particularly advantageous design of spacing members of this

5 kind is shown in WO 90/05028, which design may preferably be used also in connection with the centrifugal separator described here for cleaning of gases. One effect of spacing members formed in this way is that separated particles and/or liquid are collected along the spacing members on the undersides of the separation discs and then leave the spaces

10 between the separation discs only in limited sectors distributed around the circumference of the separation discs. This makes it possible by means of the above described ribs 78, or other means, to delimit certain parts of the space between the separation discs and the surrounding wall of the rotor for flow of substantially only gas, whereas other parts are

15 adapted to receive substantially only particles or liquid from the interspaces between the separation discs. In this way the risk can be reduced or avoided that gas which flows axially between the separation discs and the surrounding wall of the rotor should entrain out of the rotor particles having previously been separated from the gas in the spaces

20 between the separation discs.

Claims

1. Method of cleaning gases, which have been produced by a combustion engine (1), from solid and/or liquid particles suspended therein, the gases being conducted through a separation chamber formed and surrounded by a rotating member (R), by means of which the gases are caused to rotate, so that particles in the separation chamber are separated from the gases by means of centrifugal force,
- 10 characterized in
- that the combustion engine (1) is utilised for generating a pressure fluid other than that constituted by exhaust gases pressurised in the combustion room of the combustion engine, and
 - 15 - that the pressure fluid is used for the driving of the rotating member (R).
2. Method according to claim 1, in which the combustion engine (1) is utilised for pressurising air, which air is then used as said pressure fluid..
- 20
3. Method according to claim 2, in which the combustion engine (1) is caused to pressurise air, which is to be supplied to the combustion room of the combustion engine, part of this pressurised air being utilised as
- 25 said pressure fluid.
4. Method according to claim 2 or 3, in which the exhaust gases of the combustion engine are used for driving of a compressor (9), which is adapted for pressurising said air.

5. Method according to claim 1, in which a pressurised liquid is used as said pressure fluid.

6. Method according to claim 5, in which the combustion engine (1) is caused to drive a pump (16; 22; 28) for pressurising said liquid.

7. Method according to claim 6, in which liquid fuel is pumped to the combustion room of the combustion engine by means of said pump (28) and at least part of the pumped fuel is used for driving of the rotating member (R).

8. Method according to claim 6, in which lubricating oil intended for lubricating the combustion engine (1) is pumped by means of said pump (16) and at least part of the pumped lubricating oil is utilised for driving said rotating member (R).

9. Method according to claim 6, in which cooling water for the combustion engine (1) is pumped by means of said pump (22) and at least part of the pumped cooling water is utilised for driving of the rotating member (R).

10. Method according to any one of the preceding claims, in which said pressure fluid is supplied to a chamber (50) in a rotatable housing (47), which is connected with said rotating member (59), at least part of the pressure fluid being caused to leave the housing (47) through an outlet (57), which is so directed and placed in relation to a rotational axis, around which the housing (47) is rotatable, that the fluid flowing out through the outlet keeps the housing (47) and the rotating member (59) in rotation.

11. Method according to claim 10, in which lubricating oil for the combustion engine (1) is utilised as said pressure fluid and this lubricating oil is freed from particles suspended therein in the rotatable housing (47) by means of centrifugal force as a consequence of the rotation of the housing.

12. Method according to any one of the preceding claims, in which the gases to be cleaned are conducted from a crankcase (6) in the combustion engine (1) through said separation chamber in the rotating member (R).

13. Plant for cleaning of gases produced by a combustion engine (1) from solid and/or liquid particles suspended therein, comprising a centrifugal separator (2) having a rotor (R), which is rotatable around a rotational axis (68) and which delimits and surrounds a separation chamber (69), and gas conducting members (7) for conducting said gases from the combustion engine (1) into the separation chamber of the rotor (R), so that they are brought into rotation therein,

characterised in

- that the combustion engine is adapted for operating a pressurisation device (9, 16, 22, 28) for generating a pressure fluid other than that constituted by exhaust gases, which have been pressurised in the combustion room of the combustion engine,
- that the centrifugal separator (2) has a driving device (M) for said rotor (R), which driving device (M) is adapted to bring the rotor (R) in rotation by means of a pressure fluid, and

30

- that pressure fluid conducting members (14, 19, 25, 31) are adapted to conduct pressure fluid from said pressurisation device (9, 16, 22, 28) to said driving device (M) for rotation of the rotor (R).

5 14. Plant according to claim 13, in which said gas conducting members (7) are adapted to conduct gases from a crankcase (6) of the combustion engine (1) to the separation chamber of the rotor (R).

10 15. Plant according to claim 13 or 14, in which said pressurisation device comprises a compressor (9) for compression of air.

16. Plant according to claim 13 or 14, in which said pressurisation device comprises a pump (16; 22; 28) adapted to pressurise liquid.

15 17. Plant according to claim 15 or 16, in which said driving device (M) comprises a housing (47) which is rotatable around a rotational axis and has an inlet (54) for said pressure fluid and at least one outlet situated at a distance from the rotational axis and directed in a way such that fluid flowing out therethrough will cause the housing (47) to rotate.

20

18. Plant according to claim 17, in which the rotor (R) is carried by said rotatable housing (47).

25 19. Plant according to claim 18, in which said pump (16) is adapted to pump lubricating oil intended for the combustion engine (1) into the rotatable housing (47) for cleaning of the lubricating oil and simultaneous driving of the rotor (R) of the centrifugal separator (2) intended for cleaning of said gases.

20. Plant according to claim 13 or 14, in which said separation chamber (69) has a stack of frusto-conical separation discs placed coaxially with the rotor (67) and axially spaced from each other.
- 5 21. Plant according to claim 20, in which the rotor (67) has a gas inlet (74) and a gas outlet (75) situated such that gases supplied to the rotor through the gas inlet (74) are caused to flow through the spaces between the frusto-conical separation discs in a direction from the rotational axis (68) of the rotor (67).

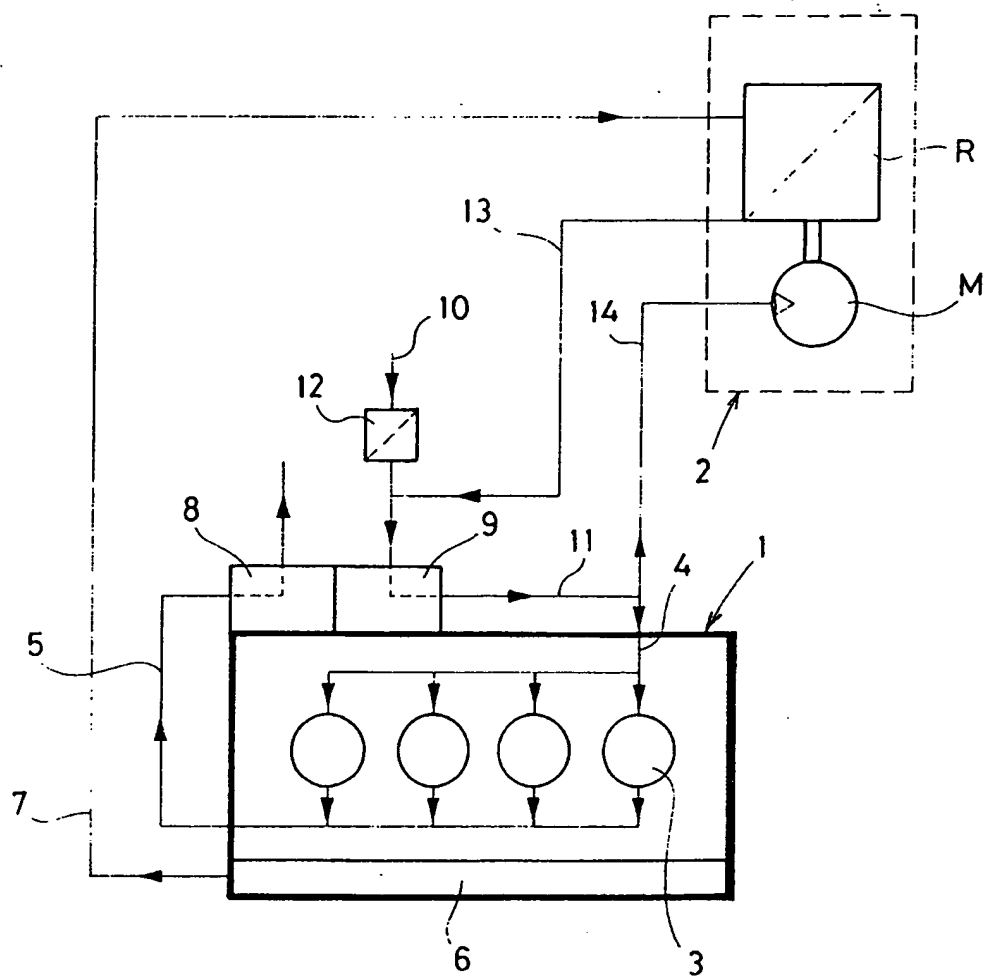


Fig.1

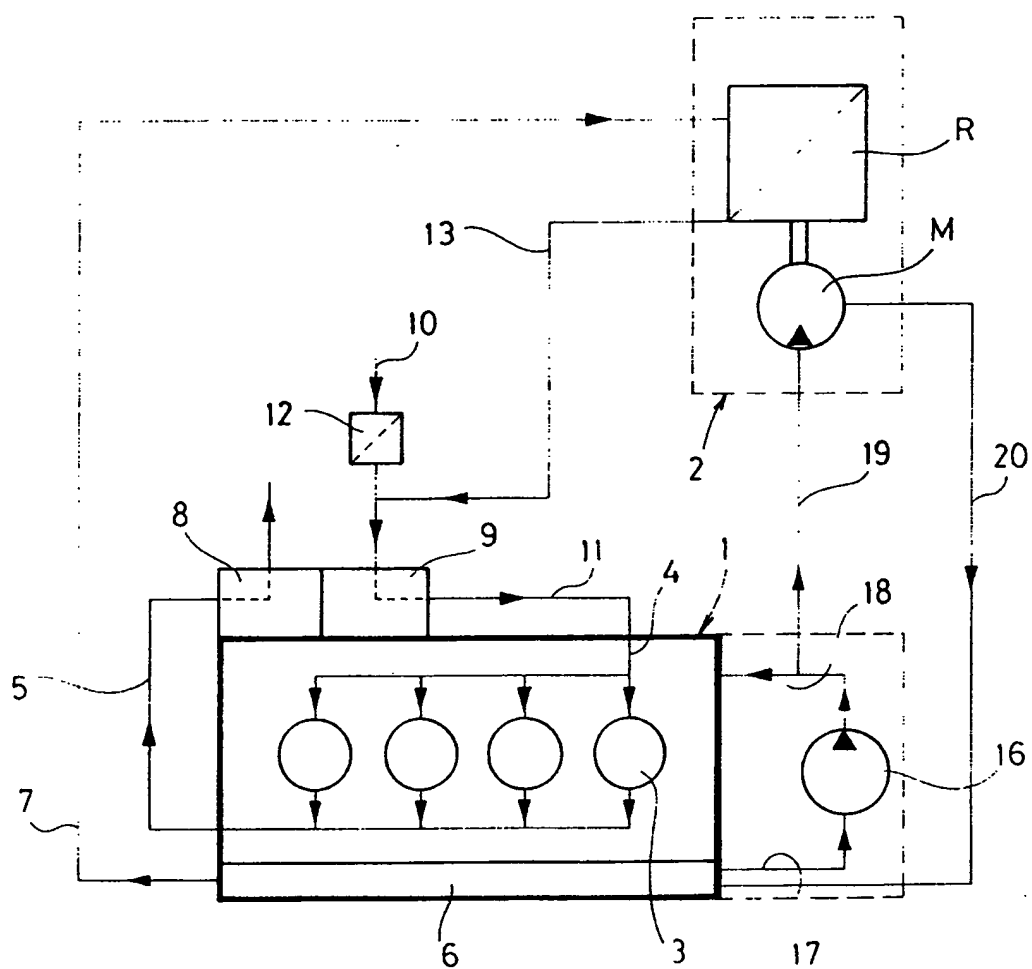


Fig.2

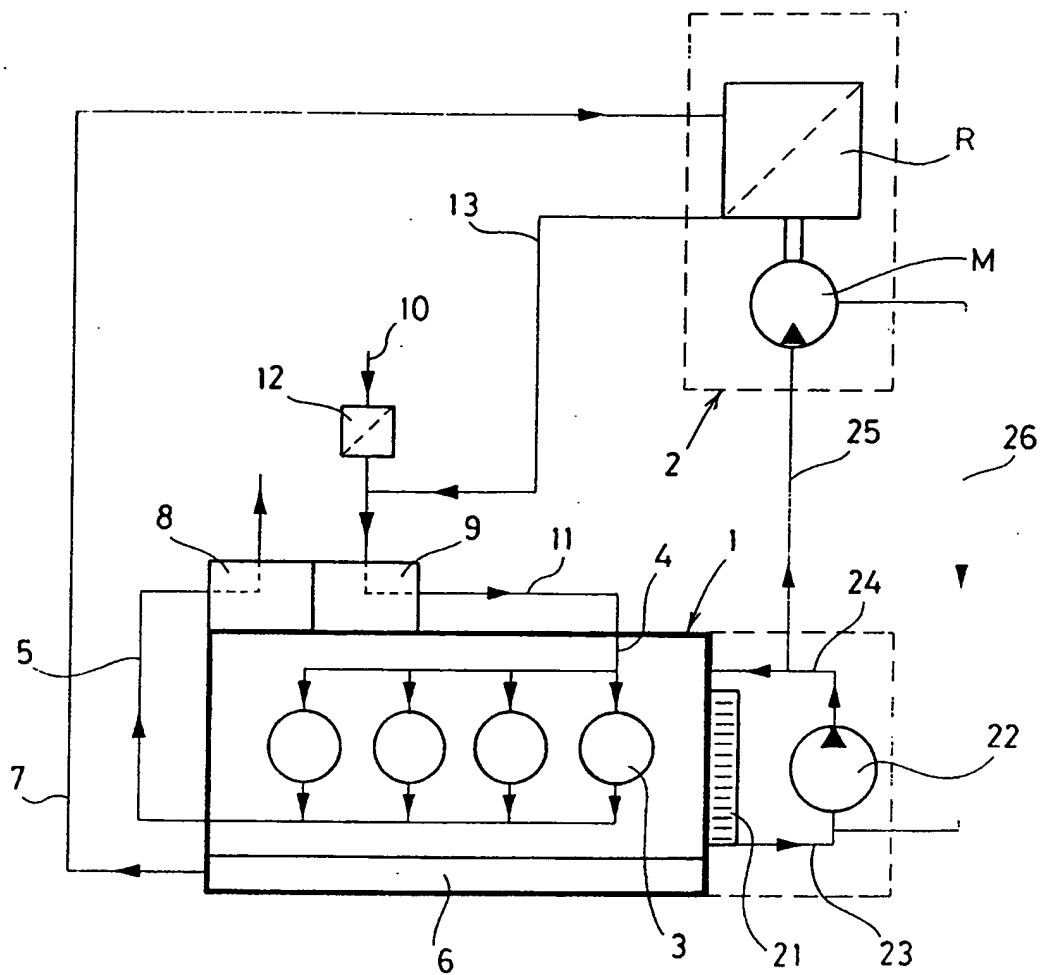


Fig.3

Fig.4

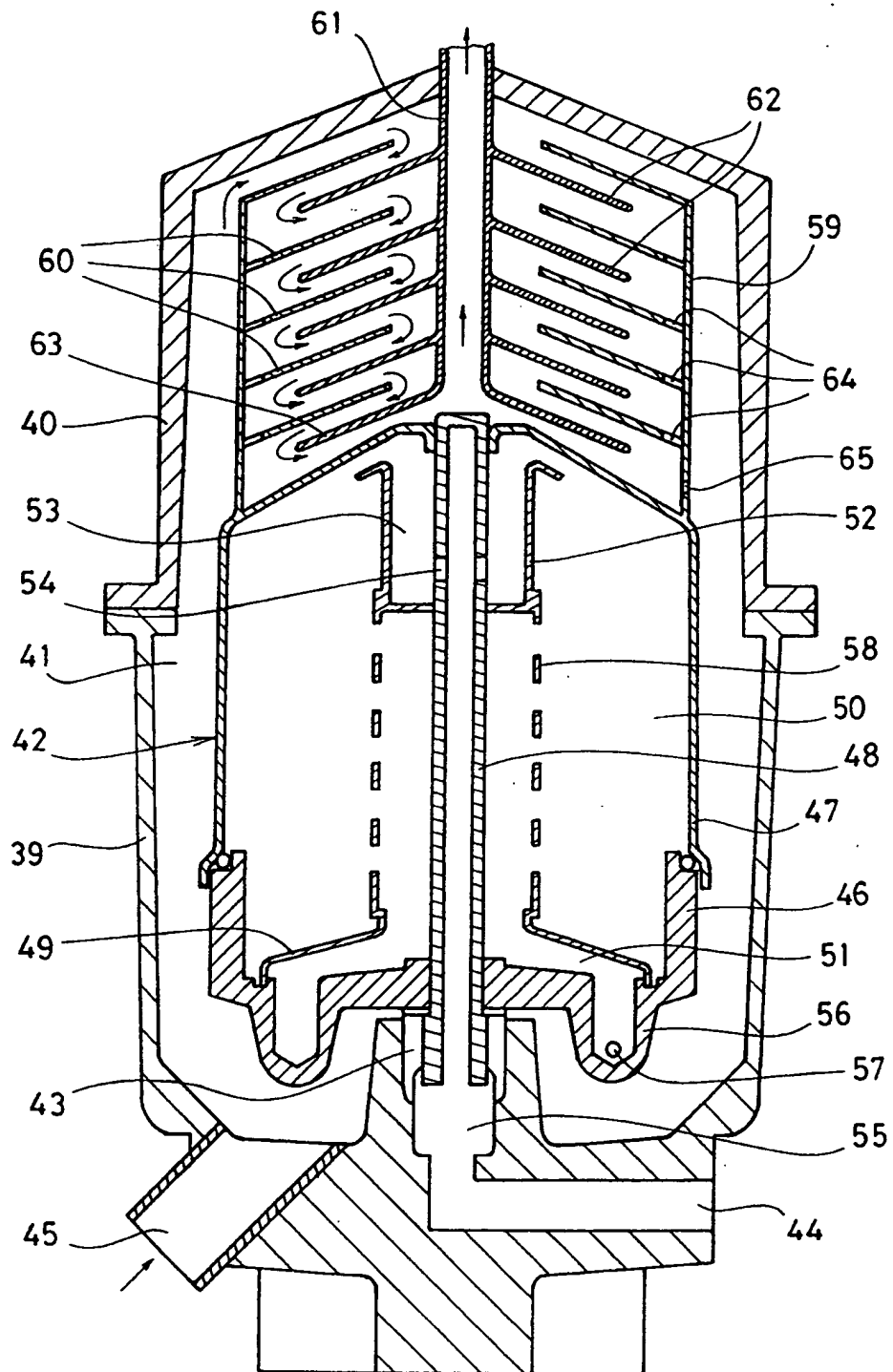


Fig.5

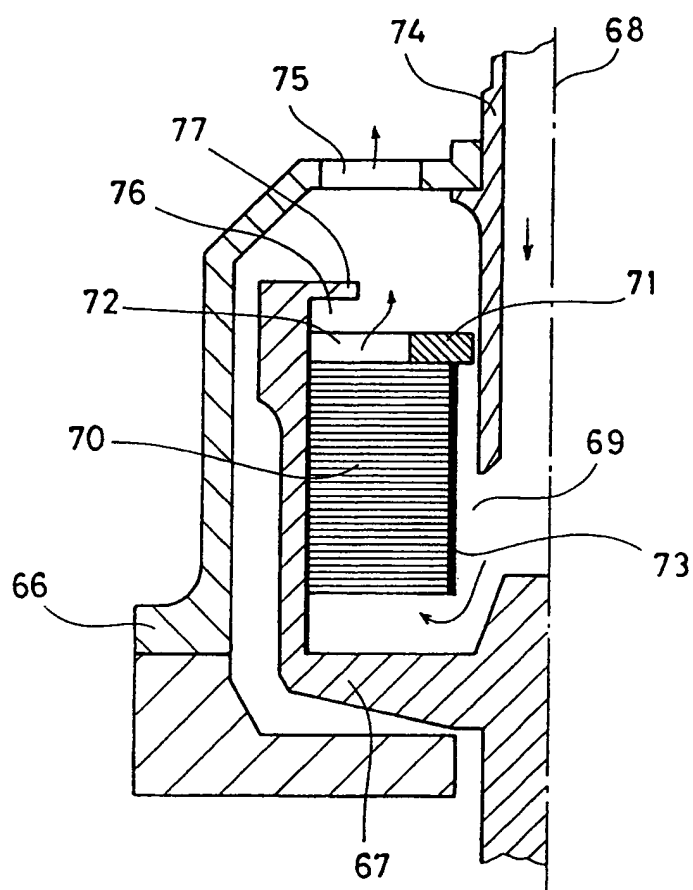
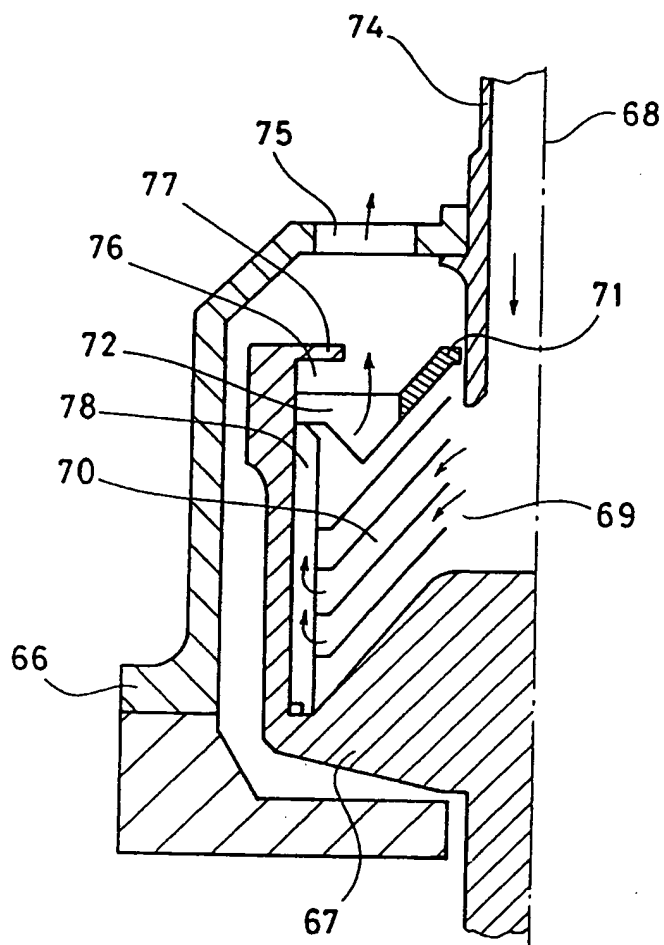


Fig.6



1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 99/00695

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B04B 5/08, F01N 3/02, F01M 13/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B04B, F01N, F01M, B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 19607919 A1 (BAYERISCHE MOTOREN WERKE AG), 4 Sept 1997 (04.09.97), abstract --	1,12-14
A	GB 1465820 A (K.H. HORNKVIST), 2 March 1977 (02.03.77), claim 1 --	1,13
A	EP 0011270 A1 (WEDEGE, E.), 28 May 1980 (28.05.80), abstract -- -----	20,21

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

10 August 1999

10 -09- 1999

Name and mailing address of the ISA
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Magnus Persson / MR
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

01/07/99

International application No.
PCT/SE 99/00695

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19607919 A1	04/09/97	NONE	
GB 1465820 A	02/03/77	NONE	
EP 0011270 A1	28/05/80	US 4265648 A	05/05/81

This Page Blank (uspto)